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The Yttralox Story as it happened- October, 1966

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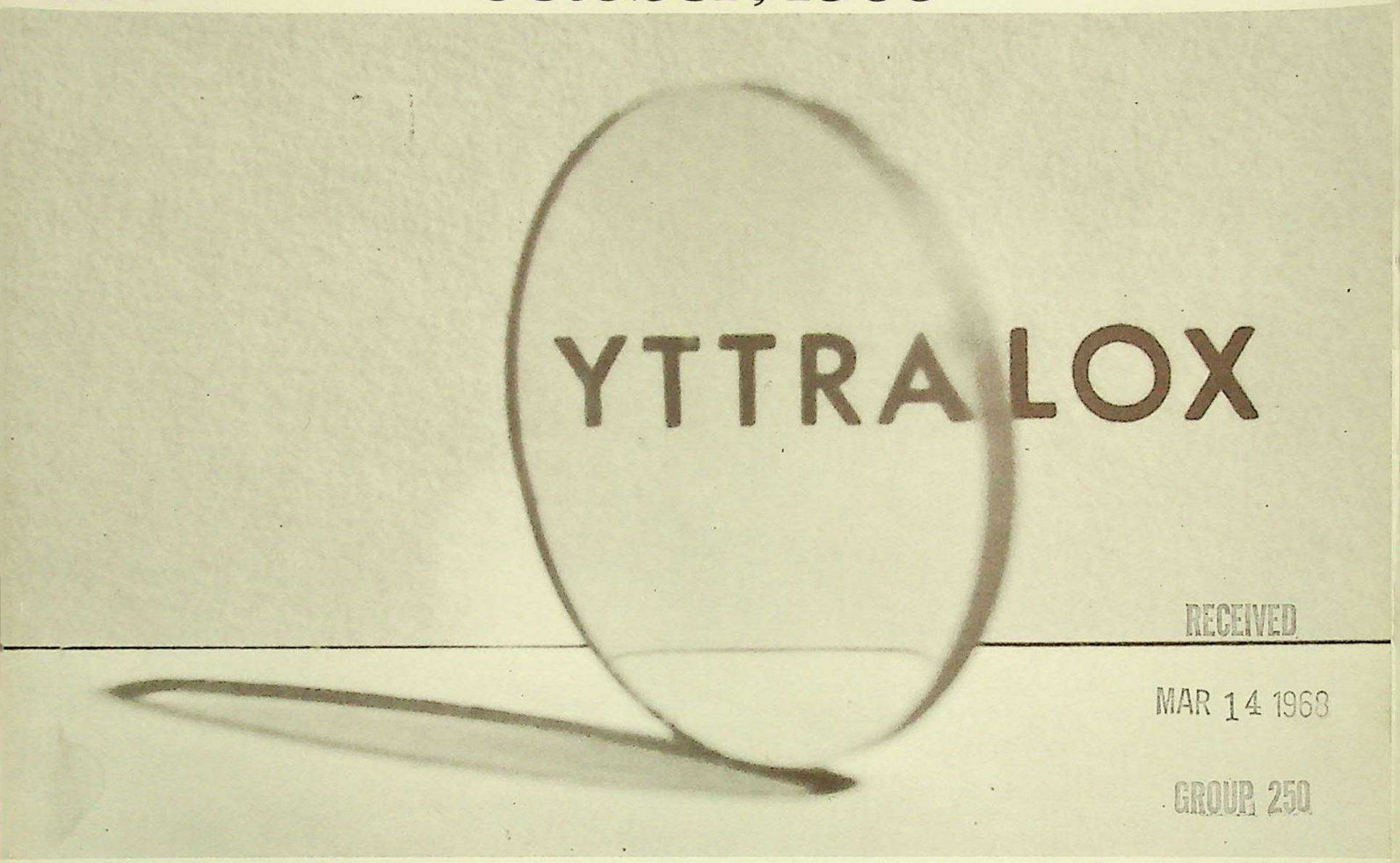

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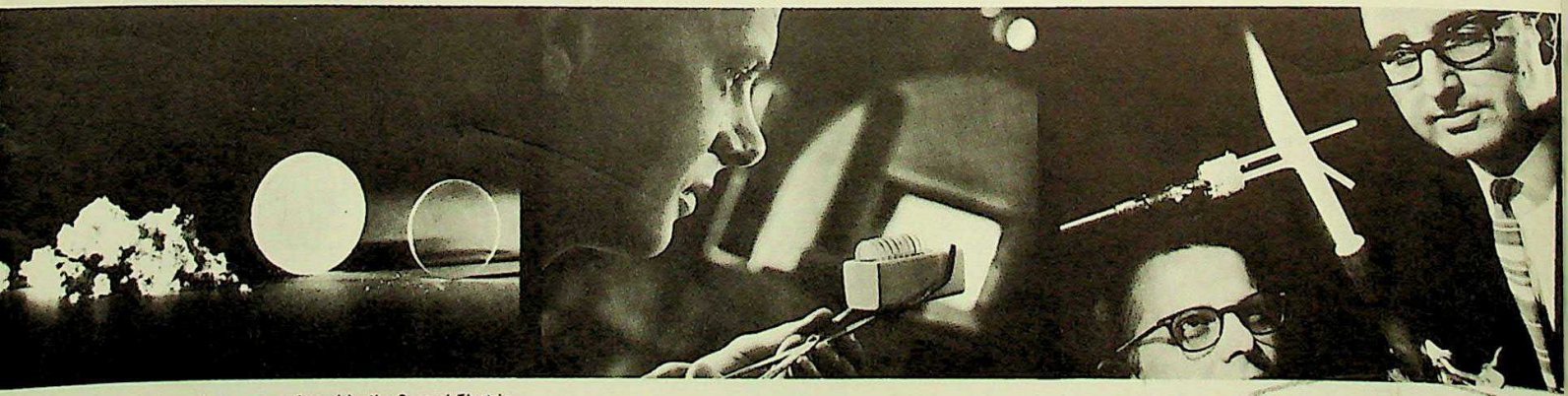
Yttralox ceramic, invented at the General Electric Research and Development Center, Schenectady, New York, withstands temperatures to 4,000°F yet transmits light without distortion. It offers exceptional transparency to both visible and infrared light with low optical dispersion and light absorption. Yttralox can be economically fabricated by ceramic processing techniques; it has potential application in industry, science and the military.

Yttralox is made basically from yttrium oxide, an opaque white powder which is then pressed and heat treated to form a polycrystalline material, which, after polishing, has the transparency of glass.

Dr. Richard C. Anderson, inventor of Yttralox, removes a test batch of the remarkable ceramic from a furnace. While glasses soften at 2,000°F to 2,600°F transparent Yttralox has a melting point beyond 4,000°F.

General Electric scientists watch a quartz rod sag at slightly above 2,600°F. But the Yttralox rod remains rigid at temperatures over 4,000°F.



The above photos were released by the General Electric Research and Development Center, October 10, 1966.

LAMP GLASS DEPARTMENT

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GENERAL ELECTRIC

O.L.

GENERAL ELECTRIC
RESEARCH AND DEVELOPMENT CENTER

PUBLIC INFORMATION

P.O. BOX 8, SCHENECTADY, N. Y. 12301 TELEPHONE 518—346-8771

FOR RELEASE MONDAY P.M., OCTOBER 10, 1966

UNIVERSITY PARK, PENNSYLVANIA, October 10, 1966 -- A space-age ceramic material as transparent as glass -- but which can withstand temperatures more than twice as high -- was announced today by General Electric scientists.

This transparent ceramic has a melting point in excess of 4,000° Fahrenheit, while glasses soften at temperatures ranging from about 2,000° F. to 2,600° F., Drs. Richard C. Anderson and Paul J. Jorgensen reported at a meeting here of the American Ceramic Society.

G.E.'s revolutionary ceramic is made primarily from yttrium oxide, an opaque white powder, and has been named "Yttralox" ceramic. In experiments at the General Electric Research and Development Center in Schenectady, New York, the material has demonstrated an exceptional transparency to visible and infrared light.

"No other known material offers the spectrum of properties found in Yttralox ceramic," Dr. Arthur M. Bueche, vice president in charge of the Center, commented today. "In addition, it can be fabricated inexpensively by ceramic processing techniques."

Potential applications for Yttralox ceramic are foreseen in a number of scientific, industrial, and military fields. Since the ceramic combines a number of desirable properties, it is expected to extend the range of instruments and devices that are presently limited by the physical characteristics of available materials.

One application may come in improved high-intensity incandescent and discharge lamps. The ceramic also may find uses as an infrared "window" for heat-seeking rockets, as a "window" into high-temperature furnaces, and in lenses for microscopes used in the study of molten samples.

In recent years, a number of scientists and engineers at the General Electric Research and Development Center have been studying the fundamental principles that determine the processing and properties of ceramics.

- more -

One earlier result of this work was the discovery, announced in 1959, of a high-temperature ceramic with excellent light transmitting properties, called Lucalox®. This ceramic -- a polycrystalline form of alumina -- now forms the arc tube of G.E.'s new Lucalox lamp, the most efficient source of white light ever developed for general illumination.

The starting material for Yttralox ceramic is a powder consisting of yttrium oxide mixed with a small amount of thoria. The powder is pressed into the desired shape, then fired at temperatures in the neighborhood of 4,000° F. This heat treatment removes the microscopically small pores, or "bubbles," from between the powder particles. Such pores scatter light and account for the opacity of conventional ceramics.

The end result of this heat treatment -- called "sintering" -- is a polycrystalline material with (when polished) the transparency of glass.

Yttralox ceramic was invented by Dr. Richard C. Anderson, a ceramist in the Center's Chemical Systems and Processes Laboratory. Further work on the ceramic material has been conducted by Drs. Paul J. Jorgensen, Joseph H. Rosolowski, and Douglas St. Pierre, of the Center's Metallurgy and Ceramics Laboratory.

A patent for the new ceramic has been applied for in Dr. Anderson's name.

Additional technical and background information.

In today's paper, Drs. Anderson and Jorgensen describe Yttralox ceramic as a transparent ceramic containing about 90 per cent yttrium oxide (Y_2O_3) with 10 per cent thorium oxide (ThO_2) in solid solution. It is a single-phase, polycrystalline material with a grain size normally between 10 and 50 microns in diameter. Yttrium oxide has a cubic crystal structure, and hence light is not scattered at grain boundaries in the polycrystalline Yttralox ceramic. This property, combined with the absence of second phase and pores, accounts for the exceptional transparency of the material.

The transmission cut-off in the ultraviolet occurs at 0.24 microns and in the infrared at about 9 microns. There are no marked absorption bands in the spectrum. The index of refraction is about 1.91 at the wavelength of the sodium D line (589.3 mu). Light absorption is as low as three per cent for a 2 mm. thick sample throughout the visible range. Incident light not absorbed or reflected from the surface is transmitted with a minimum of distortion. Optical dispersion is very low in comparison with most optical glasses with a high refractive index.

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Advanced Products Available from General Electric's Lamp Glass Department... Quartz, Lucalox® and Electronic Glass

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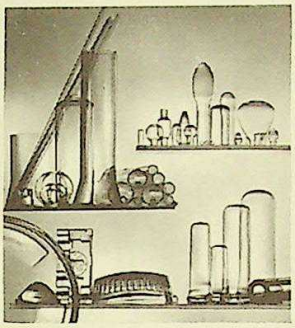
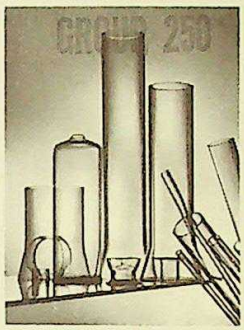
G
GLASS

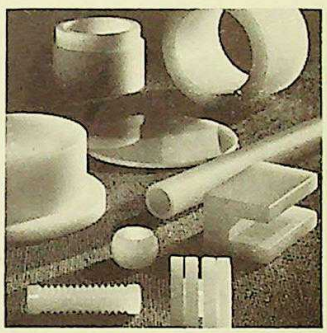
A complete line of standard and specialty electronic glass products is offered by the Lamp Glass Department of General Electric. Expert glass technologists have developed a wide choice in standard electronic miniature bulbs and other electronic glassware such as TV neck repair items. A highly experienced staff is available for customized orders in glass tubing, pressed ware, special glass formulations (beads) or other electronic glass components.





L
LUCALOX®

Lucalox®, a polycrystalline alumina, is available in standard tubing, rod, plates, discs and custom parts. This versatile ceramic is ideal for such critical applications as electrical insulators in corrosive environments, where wear surfaces require dimensional stability and for windows when low loss factor is important. Lucalox can transmit up to 90% of total light in the visible spectrum. Outstanding characteristics include: chemically inert to cesium, fluorine, sodium, potassium; transmits radiation in both visible and infrared wave lengths; surface may be polished to less than one micro-inch; high dielectric strength. Lucalox can be fabricated to complex specifications. Standard shapes in stock.



Q
QUARTZ

General Electric high purity fused quartz is available in clear and translucent tubing and rod, solid shapes, standard fabrication, and to custom specifications. In addition, fused quartz fiber products including yarn, matt, roving, overlay, and wool are manufactured. Fused Type 151 schlieren grade is available for critical optical and ultraviolet applications, schlieren windows, schlieren photography, laser optics, spectophotometer optical elements and other high ultraviolet transmission applications. Type 151 resists darkening after exposure to gamma radiation. Transmission capability is high even below 1800°A. Distortion is minimum. Other types of fused quartz are available in five optical grades of infrared, ultraviolet or full spectrum.

WORLDWIDE SERVICE. For sales and application assistance, contact your nearest regional office:

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Write for illustrated technical literature

LAMP GLASS DEPARTMENT

GENERAL ELECTRIC

24400 Highland Road • Richmond Heights, Ohio 44143

MANUFACTURERS OF LUCALOX® CERAMIC — ELECTRONIC GLASSWARE — FUSED QUARTZ PRODUCTS—JET-TEMP® AND JET-B.O.P. THERMOCOUPLES.

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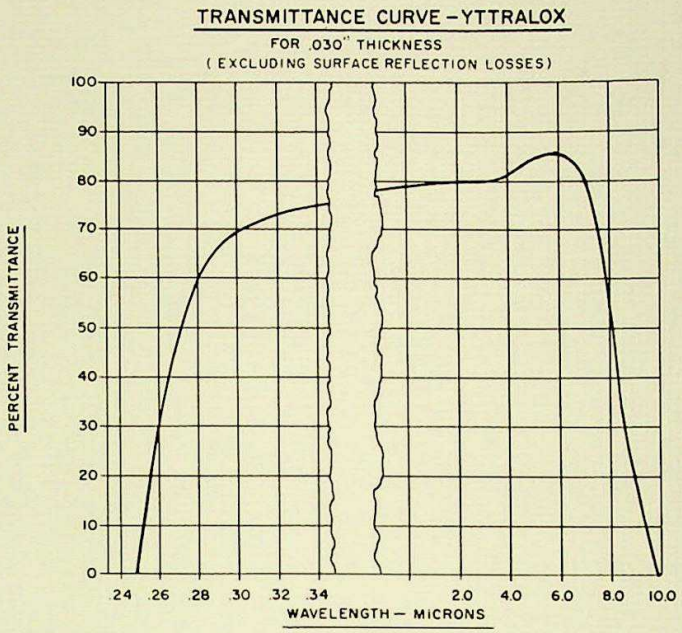
Printed in U. S. A.

PROPERTIES OF YTTRALOX

OPTICAL PROPERTIES

- In-Line Transmission ..... See Curve
- Index of Refraction ..... 1.92 at Na d line
- Dispersion-Constrigence (Nu value) 36.9
- Emissivity.. .96 microns to 3 microns = 0.0 to .04
  at 7 microns = .52



PHYSICAL PROPERTIES

- Density ..... 5.30 gm/cc
- Crystal Structure ..... Cubic
- Hardness .. 600 (10 gram load) Vickers Kg/mm²
  875 Knoop
  7.2 MOH
- Coefficient of Thermal Expansion ..... 6.7×10^{-6} (Room Temp to 1000° C)
- Modulus of Rupture ..... 17,000 psi
- Modulus of Elasticity ..... 26,000,000 psi
- Poisson's Ratio ..... 0.295 @ 25° C
  0.298 @ 1000° C
- Melting Point ..... 2400° C
- Useful Temp Limit in Air ..... 1750° C
- Porosity ..... None, Fully Dense
- Yttralox Does Not Fluoresce
- Purity ..... >99.9%

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ELECTRICAL PROPERTIES

- Dielectric Constant ..... 12 @ 10^3 cps; 12 @ 1 mc
- Dissipation Factor ..... 1×10^{-4} cps; 1×10^{-4} @ 1 mc
- DC Resistivity ..... 5×10^{10} @ 500° C
  10^6 @ 900° C

RESISTANCE

- Stability in Molten Alkali Metals ..... Sample Darkens
- Stability in Anhydrous Molten Alkali ..... Good
- Stability in High Pressure-High Temperature H_2O ..... Poor, Sample Hydrates

Yttralox can be polished to less than 1 micro inch roughness